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Processing of compound nouns: Evidence from Persian-speaking transcortical aphasics

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Abstract

This study aimed to examine the lexical performance of 1 motor and 1 sensory transcortical patients through confrontation naming, repetition and spoken picture-matching tasks to clarify how the representation of root and synthetic compound nouns takes place in mental lexicon. The analysis of the data indicated that the transcortical motor (TM) aphasic had good comprehension ability, whereas the transcortical sensory (TS) one was poor in language comprehension. The TS aphasic's performance on confrontation naming was worse than the MT patient, but she repeated words better than the other one. Based on the data, it is concluded that decomposition route is employed in repetition task, while the dual route (decomposition and holistic) is used in naming task, and the comprehension processing takes place through a distributed model.

Keywords: Transcortical motor aphasia; transcortica sensory aphasia; dissociation; distributed model; dual route model

1. Intruduction

In recent years, there has been a wide range of studies on aphasics' language behaviors to reveal some facts about the formation of language system, and the way through which mind stores, retrieves and represents the relevant information. To find out more about the relationship of language and mind/brain, researchers have paid special attention to the nature of lexical processing from a psycholinguistic point of view cross-linguistically, and by looking at the processing aspects of different categories of words, such as compounds, have been able to arrive at interesting results leading to a number of theories and models. Compound nouns consist of two or more simple lexical morphemes (free or bound) and grammatical free morphemes. Synthetic compound nouns are the elements that their syntactic head is derived from a verb, like *kamarband* (waist rope=belt) in which *band* is the head. On the other hand, root compound nouns have unknown head or their head is not derived from a verb, like *ketâbxâne* (book home=library) with the head *xâne* and *Ašotormory* (camel hen=ostrich) with unknown head. Syntactic head is the element whose category is the same as the whole word (e.g. *pirmard* "old man" whose syntactic head is *mard* "man").

With respect to the processing of compound words, psycholinguistic accounts differ markedly in that they propose different solutions for the way morphological structures are represented in mental lexicon. Basically, three

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different hypotheses compete with one another. First, non-compositional theories like the Full Listing Model claim that compounds are stored as whole words and retrieved as such (Butterworth, 1983). Compound nouns are retrieved just like simple ones and represented holistically and stored independently. Morphological information is retrieved in the absence of phonological information (Delazer & Semenza, 1998). On the other hand, compositional theories assume that all poly-morphemic words are decomposed into their constituent morphemes. Blanken (2002) concluded that German aphasics decompose nouns into their constituents, and their representation takes place under the influence of the constituents' frequency. Semenza, Luzzatti, and Carabelli (1997) found out that Italian Broca, Wernicke's and anomic patients' deletion of verbs in confrontation naming task confirmed that nouns and verbs were processed independently.

Finally the Dual Route Models are based on this assumption that morphologically complex words can either be recognized via a route using morphological parsing or via a direct route accessing morphologically compound words as full forms. Dohmes, Zwitserlood, and Bölte (2004) cite that the two most prominent examples of dual route models are the Augmented Addressed Morphology Model (AAM) and the Morphological Race Model (MRM). According to AAM, all familiar words (compound and simple) are normally processed by the lexical route, while novel compounds are decomposed and processed by the constituent route. By contrast, the MRM assumes that the direct route and the parsing route operate in parallel. Luzzatti and Bleser (1996) claim that morphological processing of simple, compound and derived nouns in Italian agrammmatic patients occur both holistically and in a decomposition way. Mondini, Luzzatti, Zonca, Pistarani and Semenza (2004) investigated the processing of verb-noun compounds by Italian aphasics, and proposed that the processing of compounds is indeed affected by the lexical category of their morphologically simple constituents, and takes place via a dual route. Libben and Jarema (2004) discuss that monomorphemic words process as whole words, whereas multimorphemic ones are decomposed into their constituents. Models of auditory word comprehension can be split into two broad classes, Localist and Distributed (Ralph, 1998). In 1962, Quillan proposed a local model of semantic processing in which all of the information concerning a given concept (e.g. cat) is mapped onto a single node that is associated with other related concepts (e.g. lion, leopard, and tiger) in a semantic network. In this model, picture recognition occurs when the node of that object is activated by observing the picture and hearing the name of the object. In contrast, a more recent model of processing is the connectionist network or distributed model proposed by Masson in the early 1990s. He believes that the distributed approach encodes each lexical item as a pattern of activation across a set of shared units. In this model, the individual semantic features are represented by different nodes. Each attribute is represented separately, so that every object activates a different pattern of features. In this way, the knowledge associated with a tiger may activate the feature nodes stripes, claws, large, feline, fierce, wild, jungle and carnivores. This pattern of features can overlap, for example, with the semantic representation of a lion that will activate all these features except stripes. However, no two items, as Breese and Hillis (2004) suggest, will activate the exact same set of features.

We tested the production pattern of two transcortical Persian-speaking aphasics to determine which mode(s) they use in processing of different categories of compound nouns in order to provide convincing answers to these questions that which nouns show more vulnerability and whether patients with different types of aphasia process compound nouns differently.

Transcortical motor aphasic's spontaneous speech is nonfluent and effortful. This type of aphasia is, thus, similar to Broca aphasia in that the spoken language is affected. The place of damage is in frontal lobe beyond the language area (Obler & Gjerlow, 2004). On the contrary, transcortical sensory aphasics behave like Wernicke's aphasics in that their spontaneous speech is fluent. The TM and TS repetition ability is better than Broca and Wernicke's aphasics respectively. Paraphasias and neologisms are accompanied by echolalia in TS patients. Their auditory comprehension is severely impaired, and the place of their damage is located outside the parietal lobe.

2. Method

2.1. Subjects

The experimental subjects include 2 monolingual Persian-speaking aphasics enrolled in speech therapy clinic of Shafa Hospital and Welfare Rehabilitation Center in Kerman, Iran. The subjects suffered from a cerebrovascular accident (CVA) causing left hemisphere damage. The initial diagnosis was made by the speech therapist, and the type of aphasia was determined based on the Diagnostic Aphasia Test of Nilipour (1994). No evidence of hearing, tactile or visual problem was observed in the patients. Two normal monolingual females matched to the aphasics participated in the study.

Case 1: The transcortical motor aphasic patient is a 54-year-old, right-handed female teacher. She had a stroke in August, 2005. Her CT scan revealed a lesion affecting the area around the left hemisphere frontal lobe. At the time of testing, no signs of severe hemiplegia were observed, but the patient's right side was weaker than the left one. Her speech was nonfluent, characterized by excessive use of paraphasias and perseverations.

Case 2: The transcortical sensory aphasic patient is a 57-year-old, right-handed female with five years of education. She suffered from a stroke in April, 2006, which based on her CT scan caused a brain damage beyond parietal lobe in the left hemisphere. At the time of testing, the upper parts of her body showed signs of hemiplegia. Her speech was fluent, but meaningless marked by excessive use of long pauses and fillers.

2.2. Stimuli

32 high frequency root and synthetic compound nouns were selected from the corpus presented in the dissertation of Khabbaz (2007). The stimuli consist of 18 roots and 14 synthetic nouns including different categories of "noun + noun", "adjective + noun" and "noun + verb stem". These nouns, their syntactic and semantic heads and their constituent categories are shown in the following tables.

Table 1. Synthetic compound nouns

Number	Compound noun	Syntactic				Part of speech
		head		Unknown	Headless	N + verb stem
		F	I			
1	medậdtarâš (sharpener)		+			+
2	rištarâš(shaver)		+			+
3	dastband(handcuff)		+			+
4	pâband (fetter)		+			+
5	kamarband (belt)		+			+
6	medâdpâkkon (eraser)		+			+
7	nậxongir (nail scissor)				+	+
8	jâru (broom)				+	+
9	pâru (snow shovel)				+	+
10	dastkeš (gloves)				+	+
11	havâpeymâ (palne)				+	+
12	xatkeš (ruler)				+	+
13	âbpâš (watering pot)				+	+
14	damâsanj (thermometer)				+	+

Adj = Adjective
F= Final
I= Initial
N= Noun

Table 2. Root compound nouns

Number	Compound noun	Syntactic			Part of speech	
		head		Unknown Headless	N + N	ADJ + N
		I	F			
1	*toxmmorγ* (egg)	+			+	
2	*râhâhan* (rail road)	+			+	
3	*mâšinhesâb*(calculator)	+			+	
4	*mâšintahrir* (type writer)	+			+	
5	*čerâγqovve* (torch)	+			+	
6	*ruznâme* (paper)		+		+	
7	*ketâbxâne* (library)		+		+	
8	*kamânarre* (saw)		+		+	
9	*gurxar* (zebra)		+		+	
10	*zabtesot* (cassette player)			+	+	
11	*šotormorγ* (ostrich)			+	+	
12	*lâkpošt* (turtle)			+	+	
13	*xarčang* (crab)			+	+	
14	*gâvsanduγ* (safe)		+			+
15	*Pirmard* (old man)		+			+
16	*ranginkamân* (rainbow)		+			+
17	*xarguš* (rabbit)		+			+
18	*zardâlu* (apricot)		+			+

Adj = Adjective
F= Final
I= Initial
N= Noun

2.3. Tests

Three tasks of confrontation naming, repetition and spoken word-picture matching tasks were designed and conducted. The stimuli of the confrontation naming task are 32 black and white intermixed line drawings of objects pertaining to root and synthetic nouns. They were shown to the participants who were required to name them only one time and their true or false responses were tape recorded. In the repetition task, the same lexical stimuli in confrontation naming task were employed, and the aphasics were asked to repeat them after the examiner. Their performance was recorded, and then their errors were analyzed. The spoken word-picture matching task is a Persian adaptation of the PALPA battery (Kay, Lesser, & Coltheart, 1992) used for the assessment of language processing in aphasia. Subjects were required to point to a target picture named by the examiner from a set of five pictures containing a target, a semantically close, a semantically distant related picture, a visually similar distracter and an unrelated distracter. There are 32 items in this task.

2.4. Procedure

The tests were administered to each aphasic subject in 3 sessions with an interval of 5 days between them. Each compound noun was shown as a black and white line drawing in the confrontation naming and spoken word-picture matching tasks. The confrontation naming and the repetition tasks were administered in 14 and 10 minutes respectively for each subject, and then the spoken word-picture matching task was held in 20 minutes. All tasks were performed in the speech therapist's clinic. Prior to testing, a brief training session preceded the actual tests.

3. Results

The normal subjects scored 100% correct on all of the tests developed for this research. The analysis of the data is presented separately for each test in the subsections below.

3.1. Confrontation Naming Task

3.1.1. TM aphasic

The TM aphasic patient named 3 synthetic compound nouns correctly from a set of 14 nouns. Her errors are: 4 omissions, 1 circumlocution, 3 simple noun substitutions, 2 semantic verbal paraphasias and 1 formal paraphasia. She named 2 compound nouns correctly from 18 root nouns. Her errors are as follows: 8 omissions, 2 circumlocutions, 1 simple noun substitutions, 4 semantic verbal paraphasia and 1 formal paraphasia.

Table 3. TM aphasic's error types in confrontation naming task

Error type	Part of speech			AC			Total
	N + V stem	N + N	Adj + N	1	2	1& 2	
Omission	4	6	2				12
Circumlocution	1	1	1		1		3
Simple for compound	3	1				4	4
Semantic verbal paraphasia	2	3	1			6	6
Formal paraphasia	1	1	0	2			2
Total	11	12	4	2	1	10	27

Adj = Adjective
F= Final
I= Initial
N= Noun
TM= Transcortical Motor
V= Verb
AC= Affected Constituent

According to these data, TM patient made 27 errors overall. Most of her errors (11 errors or 34/37%) are related to nouns comprising "noun + noun" category and 'noun + verb stem" had the most errors (12 errors and 11 errors respectively). On the whole, data analysis demonstrated that omission and semantic verbal paraphasia with 37/5% and 18/75% are the most frequent errors made by the TM aphasic. Among the 27 errors, 10 errors involved changing both constituents, whereas 5 errors were related to the second constituents and 2 to the first constituents of compounds.

3.1.2. TS aphasic

The TS aphasic patient produced 2 nouns correctly from a total number of 14 synthetic nouns. Her errors include 7 omissions, 2 simple noun substitutions, 2 semantic verbal paraphasias and 2 formal paraphasias. She produced 3 compound root nouns correctly out of a total of 18. Her errors include: 5 omissions, 6 simple noun substitutions, 5 semantic verbal paraphasias, 1 formal paraphasia and 1 constituent displacement.

Table 4. TS aphasic's error types in Confrontation Naming Task

Error type	Part of speech			AC			Total
	N + V stem	N + N	Adj + N	1	2	1 & 2	
Omissions	7	4	1				12
Simple for compound	2	3	3			8	8
Semantic verbal paraphasia	2	2	3			7	7
Formal paraphasia	2	1		1		2	3
Constituent inversion		1				1	1
Total	13	11	7	1		18	31

Adj = Adjective
F= Final
I= Initial
N= Noun
TM= Transcortical Motor
V= Verb
AC= Affected Constituent
TS= Transcortical Sensory

The overall analysis of the errors exhibits that the patient made mistakes in compounds comprising "noun + verb stem", "noun + noun" and "adj + noun" categories involved the most errors respectively. In total, 18 errors were made on both constituents, and only 1 occurred on the first constituent of compounds.

3.2. Repetition task

3.2.1. TM aphasic

This patient repeated 25 root and synthetic compound nouns correctly, and was not able to repeat 4 synthetic and 3 root nouns. She produced 6 formal paraphasias and 1 semantic verbal paraphasia. Compounds comprising "noun + verb stem" categories with 4 errors were the most difficult nouns to be repeated. All errors resulted from a phonological change in the first constituent of the compound nouns.

3.2.2. TS aphasic

She repeated 30 root and synthetic compound nouns correctly, and produced only 2 formal paraphasias related to noun comprising "adj + noun" category. These errors resulted from a phonological change in the first constituent of the compounds.

3.3. Spoken word-picture matching task

3.3.1. TM aphasic

In this task, the TM patient made no errors in matching synthetic nouns to pictures, but made 7 errors (21.78%) in root compounds. In 2 errors, the patient pointed to the semantically distant picture, and in 5 nouns she selected the visually related picture. Most errors involved nouns comprising "noun + noun" category.

3.3.2. TS aphasic

The TS patient pointed to correct pictures for only 4 compound nouns from a total of 32, and was unable to retrieve 28 nouns (87.5%). With respect to 12 items, she pointed to the semantically close picture, and in 10 and 6 errors, she chose the visually related and semantically distant pictures respectively. Nouns comprising “noun + noun” and “noun + verb stem” category (each with 14 errors or 43.75%) had the most errors.

4. Discussion

This study examines and compares the performance abilities of 1 TM aphasic and 1 TS aphasic in auditory comprehension and oral production of root and synthetic compound nouns. The findings of this research demonstrated that TM aphasic’s naming ability in confrontation naming task is somewhat better than TS aphasics. However, both aphasics showed poor naming performance. The statistical analysis showed that the total number of the transcortical aphasics’ errors is as follows: 24 omissions, 12 simple noun substitutions, 13 semantic verbal paraphasia, 5 formal paraphasia, 3 circumlocution and 1 constituent displacement. The evidence related to simple noun substitutions (e.g., *ketâb* ‘book” in place of *ruznâme* “newspaper”) and semantic verbal paraphasias (e.g., *âhu* “gazelle” in place of *rištarâš*) constituting the majority of errors in the performance of both patients suggest that aphasics omitted both constituents of compound nouns and produced a simple noun. This indicates that they processed compound nouns in a holistic manner. The two aphasics also showed evidence of omission of a constituent of some compound nouns. For example, they produced “nâxon and lâk in place of nâxongir (nail scissor) and lâkpošt (turtle) respectively. They also made the formal paraphasia errors like *marguš* and *’âru* in place of *xarguš* (rabbit) and jậru (broom) which shows that aphasics omit one constituent or change phoneme(s) of a constituent. In other words, they omitted or changed one of the “noun + noun”, “noun + verb stem” and “adjective + noun” constituent categories. If these compound nouns were processed as a whole, there would be no reason for transcortical aphasics to omit a constituent of the noun. This result provides a strong indication that compound nouns are parsed into their component parts in the course of lexical retrieval. Therefore, with respect to these findings, we can propose that compound nouns are processed via a dual route, i.e. both compositional and non-compositional.

The TS patient repeated 30 (94%) compound nouns, while the TM patient repeated 27 (87.12%) compound nouns correctly. This shows that both patients performed well in this task. Both phasics made formal paraphasia errors. For example they repeated s*otormory* and *xorxmory* in place of *šotormory* and *toxmmory* respectively. These errors which resulted from a phoneme change in adjective, noun or verb constituent provides the evidence that the patients used a compositional strategy in the repetition task. This finding suggests that patients who are unable to retrieve compound nouns may still retain morphological knowledge about the target compound nouns in the absence of the ability to retrieve the phonological form of them. This result is consistent with Semenza et al. (1997) and Delazer and Semenza (1998) who mention that the morphological information of compound nouns is processed independently of phonological information. This finding reinforces the view of the dissociation of language competence modules.

The TM aphasic recognized 25 pictures of compound nouns correctly in spoken word picture matching task, while the TS aphasic had 4 correct answers, demonstrating that the TM subject showed a higher auditory comprehension ability than the TS one (73% versus 21%). Although the TS patient had a poor comprehension performance as compared to TM patient, both aphasics retrieved compound nouns which were semantically close, semantically distant and visually related to the target noun. This indicates that the aphasics did not choose the unrelated nouns at all, but picked those pictures which had some common features with the target ones. Based on these results, it can be concluded that comprehension is processed based on a distributed model in which the semantic features represented by different nodes are linked to each other. This is in line with the findings of Breese and Hillis (2004) and Ralph (1998).

The aphasics’ variable performance in spoken word picture matching, confrontation naming and repetition tasks of this research confirms the dissociation between oral production and auditory comprehension. This leads to the conclusion that impairment of one aspect of language does not necessarily cause deficit in the other. The Persian-speaking aphasics’ performance in the confrontation naming task corresponded to a dual route model, whereas they uniformly used a compositional model in repetition and a distributed model in the comprehension tasks.

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